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Transient Cardiac Sinus Dysrhythmia Occurring After Cold Water Immersion

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A variety of cardiac dysrhythmias are known to occur as a result of accidental hypothermia.[1,2] The overall incidence and types of human cardiac electrical disturbances that occur as a result of occupational exposure to cold water is uncertain. We describe a transient form of sinus dysrhythmia in 5 professional divers after 2 hours in cold water.

Five physically fit men (26 ± 5 years old, body weight 88 ± 14 kg, body fat 20 ± 6%) were participating in open water training dives with a diver propulsion vehicle. Each wore a standard neoprene wet suit and breathed compressed air to a maximum depth of 12 meters of sea water. Minimal physical exercise was involved during the 2-hour training sessions in 2°C water. Each diver made 2 dives, with an interval of 48 hours between dives. A 6-minute continuous rest precordial electrocardiographic tracing was recorded on magnetic tape before each dive and within 15 minutes of completion of the dive. A similar tracing was recorded on a nondiving day. Each tape was analyzed with the aid of a computer that calculated instantaneous heart rate from the corresponding RR interval. All electrocardiographic findings were normal except for the occurrence of abrupt sinus pauses. With respect to the preceding beats, sinus pauses were characterized by a single beat increase in the RR interval of at least 50%. After each pause, 1 to 3 beats were required for heart rate to return to its inherent frequency. At least 4 beats occurred at the inherent frequency before the next observed sinus pause.

Sinus pauses were evident in 9 electrocardiographic recordings (of a total of 25 recordings in the 5 divers), with pauses noted in 7 recordings obtained immediately after a dive and in 2 predive recordings. No tracings recorded on the nondiving day showed evidence of sinus pause. Four of the 5 divers exhibited 1 or 2 episodes of sinus pause in postdive recordings. The fifth diver had 8 episodes of sinus pause after his first dive and 15 after his second dive.

Figure 1 presents segments of the electrocardiogram recorded from the fifth diver. Although the postdive baseline recording contains shivering artifact, all

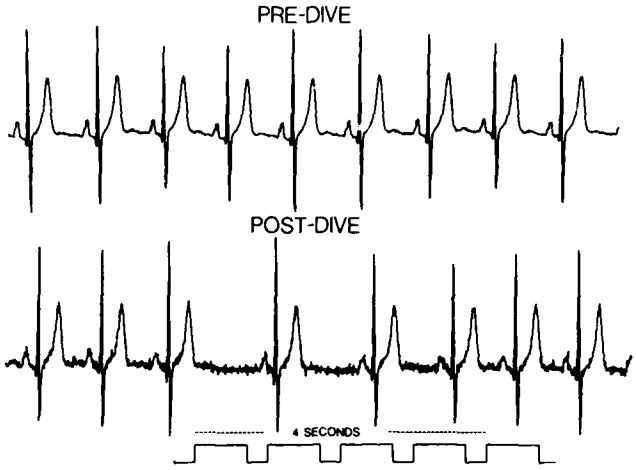

FIGURE 1. Electrocardiographic recordings obtained on the second dive day in diver 5. *Top*, recording before dive; *bottom*, recording obtained 15 minutes after dive. Interval between third and fourth beats on lower recording indicates abrupt sinus pause.

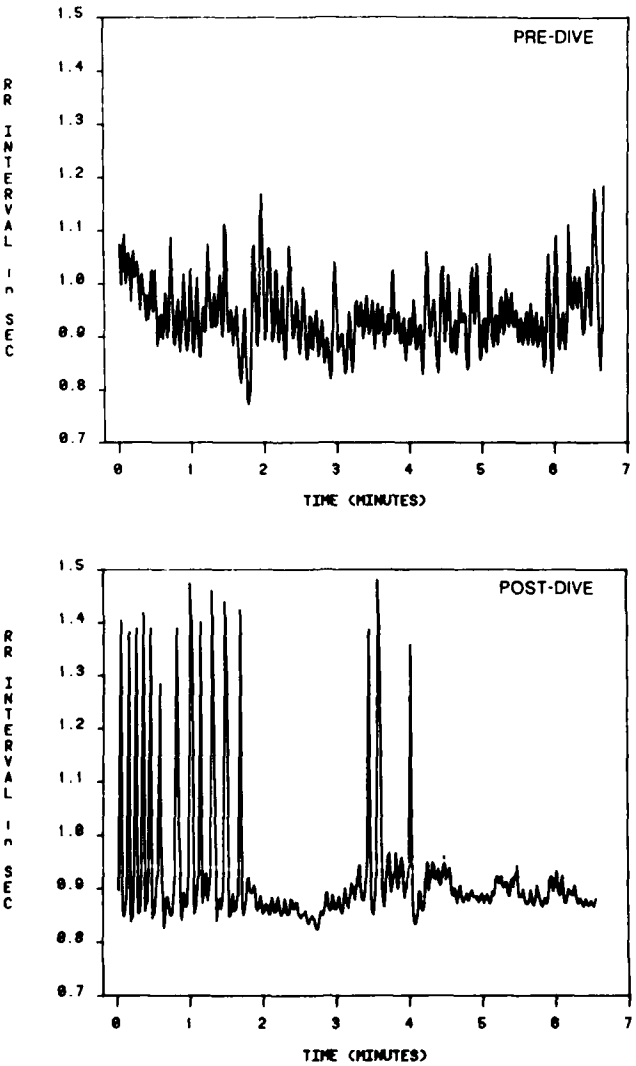

FIGURE 2. RR interval data on second dive day in diver 5. *Top*, before dive; *bottom*, after dive. The 15 upward spikes on the postdive recording reflect the sinus pauses. The postdive reduction in normal RR variability was a consistent finding in all divers.

From the Diving Medicine Department, Naval Medical Research Institute, Bethesda, Maryland 20814-5055. This work was supported by the Naval Medical Research and Development Command Work Unit No. M0099.01A.0007. The opinions and assertions contained herein are the private ones of the authors and are not to be construed as official views of the Department of the Navy or the naval service at large. Manuscript received October 9, 1986; revised manuscript received and accepted January 16, 1987.

the complexes appear to be sinus in origin, with no marked diminution of P-wave amplitude or prolongation of the PR interval. However, the third postdive RR interval is noticeably increased, reflecting a sinus dysrhythmia. This type of recording was characteristic of all sinus pauses noted.

Figure 2 shows the RR intervals measured in the fifth diver on the second dive day. The 15 upward deflections in the postdive record are each due to the type of sinus pause shown in Figure 1. Most of the pauses were present during the first 2 minutes of the recording. A subsequent recording obtained 15 minutes later had no evidence of sinus pause.

This report describes a nonpathologic dysrhythmia associated with cold water exposure. Qualitatively similar fluctuations in heart rate have been noted immediately after brief treadmill exercise and were attributed to phasic alterations in vagal tone.[3] Although no direct tests of vagal function were conducted in the present report, an abrupt change in parasympathetic tone may have contributed in some manner to the sinus pauses. A direct relation to exercise can be ruled out in the current findings because the divers were performing minimal work while underwater. Scuba diving itself was probably not a significant factor because of the relatively shallow depth. Dysrhythmias observed with scuba dives in pool water at 24 to 28°C tended to be ventricular or supraventricular extrasystoles rather than sinus pauses.[4,5] We found no sinus pauses in a laboratory study involving immersion in 32°C water, suggesting that immersion alone was not a principal factor.

Exposure to cold water appeared to be the central factor related to the sinus dysrhythmia. Postdive decreases in skin and rectal temperatures of 5.3 ± 0.7 and 0.3 ± 0.2°C, respectively, indicate a loss of body heat that may have sensitized the sinus node, perhaps causing it to respond inappropriately to a normal reflex. For example, a normal respiratory reflex produces prolongation of the RR interval during expiration.[6] Although we had no respiratory cycle measurements to correlate with the sinus pauses, none of the divers had visible signs of pronounced dysrhythmic breathing. Periodic subtle changes in breathing, particularly during expiration, may provoke an exaggerated response in a sensitized node that would result in an abrupt sinus pause. This hypothesis must await further testing.

No electrocardiographic records were obtained while the divers were actually in the water, and thus we could not document the dysrhythmia during the dive. Further, marked sinus dysrhythmia occurred in only 1 of 5 divers, for an incidence rate of 20% in this small sample group. In a subsequent study we noted sinus pauses during 55% of 60 immersions in 5°C water. Thus, abrupt sinus pauses are apparently relatively common during cold water diving. Although this form of dysrhythmia is considered benign, further laboratory investigations are necessary to document its physiologic mechanism.

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